Exciting electricity teaching materials : The Ghost and the Invention Device

Karttunen, Marianna

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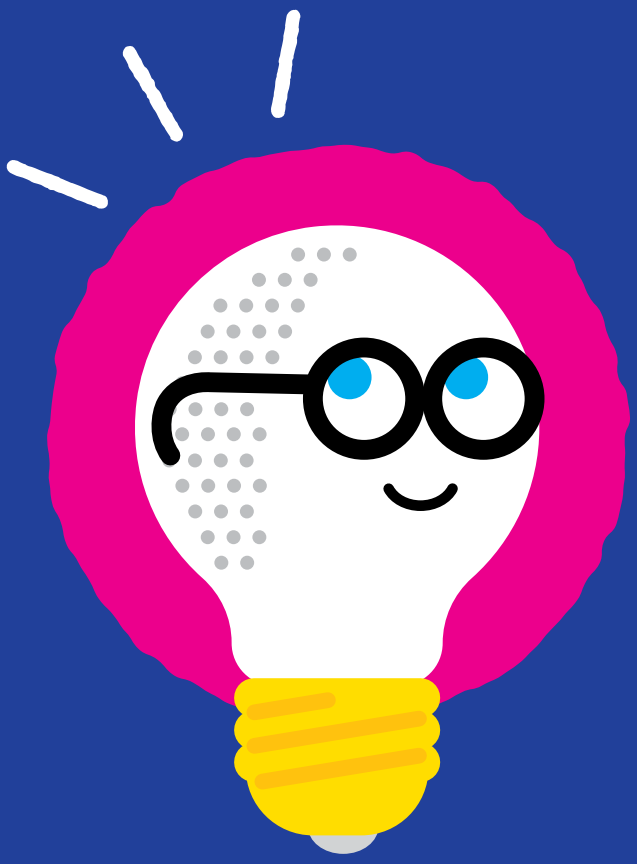
MARIANNA KARTTUNEN AND MERIKE KESLER

Exciting electricity teaching materials



THE GHOST

& the Invention Device

MUSEUM OF TECHNOLOGY

MARIANNA KARTTUNEN AND MERIKE KESLER

Exciting electricity teaching materials

The Ghost and the Invention Device

Museum of Technology
and The Finnish Association of Electrical Safety STEK ry
Helsinki 2019

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The Ghost and the Invention Device
The Sparkling electricity teaching materials
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MUSEUM OF TECHNOLOGY

STEK
Sähköturvallisuuden Edistämiskeskus ry

THE GHOST & the Invention Device

Contents

Appendices

1

Electricity as a phenomenon and learning material

WHAT WOULD our day-to-day life be without electricity? Very different, to be sure!

Electricity has become such a given that we often forget its existence. Electrical technology and its uses are developing at a blistering rate. The new developments are based on prior research, knowledge & expertise. The museum provides an excellent framework for examining electricity from a wide perspective: through authentic items and a diverse exhibition environment.

”The Ghost and the Invention Device” exhibition encourages children to explore the nature of electricity and technology through the ages and helps them to bridge together the past, our current times and the future.

THE SPARKLING ELECTRICITY teaching materials are intended for preschool and early education teachers. The materials offer activities for use at the museum exhibition. They also enable the exhibition content to be examined outside the museum through a variety of exercises.

The exhibition delves into the day-to-day use of electricity in different times, changes in technology and infrastructure, familiar and unfamiliar technology, and the recycling of various devices. According to the principles of the national curriculum for early education (National Agency for Education, 2014), learning and thinking among children can be developed and supported through a variety of means linked to methods such as experimentation, problem solving, exploration, play and diverse learning environments.

THESE LEARNING MATERIALS focus on education regarding technology and the environment. By means of varied exercises, children can also develop their mathematical skills. The exercises guide children to observe, experiment with classify, analyse, organise and measure things.

THE MATERIALS CENTRE around five themes. The first exercise portion of each theme is to be completed directly at the museum. Every theme also includes related applied exercises which the children can complete in their own learning environments. Teachers can pick the activities that best suit their groups.
All of the museum exercises can be completed during a single museum visit.
You should set aside 1–3 periods for covering each theme.

Enjoy electrifying insights in learning about electricity!

Marianna Karttunen & Merike Kesler

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Electricity arrives in Finland

▸ Acknowledging the prevalence of electrical devices in modern life and the fact that, in the past, many of them were vastly different.

▸ Considering and learning that electricity can be produced in different kinds of power plants.

MUSEUM EXERCISES

A Puzzle:
You use this item on a daily basis, usually in the morning and evening. It can be either manually or electrically operated. It was invented more than 500 years ago. Your teeth are very fond of it. Can you find this item in the museum? Draw the kind you have at home!

B What devices were used when there was no electricity?
Find the past equivalents to modern devices in the exhibition.

A Examine the environment:
which devices use electricity? Count the number of devices.

B Study the images.
- Link the form of energy and power plant.
- Come up with a motion and sound for each power plant type.
- Commit the power plants to memory using the sounds and motions!

2

EXPLORING THE TOPIC IN YOUR OWN ENVIRON-MENT

PROBLEM RESOLUTION EXERCISES

A Select a picture of an old item. Count how many corresponding new items/devices you can find in your own environment.

B What will electrical technology look like in the future?
Design and draw a toothbrush of the future.

C Help! The power is out!
It is dark outside and you need to pack your schoolbag.
Where do you get light from? Draw the solution.

APPLIED EXERCISES

A Consider the diversity and development arc of electrical devices.
Visit a local museum with the children: does the museum contain old-timey equivalents to modern devices?

B Is your school/day care centre near a power plant? What kind of power plant is it? Find out where your school/day care centre purchases electricity.

3

Electricity in the city

- Practice observing the constructed environment.
- Examine where and why electricity is used in cities.

MUSEUM EXERCISES

A Puzzle:
What vehicle is this? It travels on rails. It has ”antennae” on the roof.
In Finland, you can travel on it in Helsinki and Tampere.

B Examine the pictures of the urban environment in Helsinki.
Can you find the picture with...
‣ an electrically powered device used to control traffic. The red light means stop and the green light means go.
‣ no electrically powered vehicles at all. The picture features a vehicle pulled by an animal.
‣ a vehicle containing many devices and systems powered with electricity. Its doors are opened and closed with electricity. If you want to get off the vehicle, you need to press the STOP button.
‣ a lot of city lights. Lights make navigating the city easier and safer.
Can you identify the building in the picture?
‣ an electric vehicle that operates in Helsinki. It can be identified by the orange colour. Can you name stations where this vehicle stops?

3

EXPLORING THE TOPIC IN YOUR OWN ENVIRON-MENT

ORIENTATING EXERCISES

A Study the drawing and find the items where electricity is needed.

B Use the sound to determine what type of the vehicle it is.
Examples of traffic sounds can be found here
→ https://papunet.net/materiaalia/äänipankki/luokka/liikenne

PROBLEM RESOLUTION EXERCISES

A Draw a vehicle of the future that runs on electricity.
The vehicle can transport at least four people at a time and it travels off the ground.

APPLIED EXERCISES

A Create a story called ”My trip in Helsinki”.
▸ The story includes using various modes of transport to travel to different locations in Helsinki during one day. Select the locations and vehicles.
In what order will you be going to the locations and what can you do there?
You can find more information on the vehicles that can take you to these locations online! Which ones of the vehicles run on electricity?
▸ Example locations: Finnish Museum of Natural History, Linnanmäki, Museum of Technology, Kauppatori, Seurasaari and Suomenlinna.
▸ Modes of transport: bus, train, tram, ferry, metro, bicycle and electric scooter.
▸ Imagine a story (create an animation where possible) by drawing modes of transport and places.

B Visit a local museum and ask the staff to tell you how the local environment has changed. Which ones are new buildings and which ones are old? Where have roads been added? When did electricity first arrive there?

C Visit a local service centre for the elderly and interview an elderly person. What was their normal school trip like and what modes of travel were used in the past? When did electricity come to their home town?
Draw a picture based on the interview.


12:15
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4

Electrical devices in the home and storing electricity

▸ Learn about observing and classifying electrically-powered devices based on their purpose of use.

▸ Learn about categorising devices based on whether they are powered by a battery or mains electricity.

MUSEUM EXERCISES

A Puzzle: Which device is this? It can produce a picture and sound. It can have buttons on it. The device is not normally used for writing. It features a power cord. For the device to function, the cord needs to be connected to a socket.

B Examine the unknown device in the picture.
Draw a picture on how you think the device is used.

C Find the devices/items that match these descriptions in the exhibition:

▸ This device uses electricity to produce heat.
▸ This device uses electricity to produce sound.
▸ This device uses electricity to produce movement.
▸ This device uses electricity to produce light.
▸ This device uses electricity to produce an air flow.

4

EXPLORING THE TOPIC IN YOUR OWN ENVIRON-MENT

ORIENTATING EXERCISES

A Examine your immediate environment and pick two electrical devices with a power cord. Which device has a longer cord? Measure the cord.

B Examine your immediate environment.
Can you find electrically-powered devices or items that produce...
▸ heat ▸ sound ▸ movement ▸ light ▸ air flow
How many items did you find?

C 'Tangled power cords' puzzle (→ handout in Appendix 2).

PROBLEM RESOLUTION EXERCISES

A 'Build a power cord' game. You will need 5–10 pictures of electrical devices with a cord + one picture of a power socket (→ examples in Appendix 3). Place the socket on the ground and the various devices at suitable distances. The children are tasked with forming a "power cord" from a device to the power socket. For the device to function, the children must be connected to each other in some way. The further the device is from the socket, the more they will need to stretch their limbs! The closer the device is, the closer the children will be to each other.

APPLIED EXERCISES

A Examine electrically-powered devices that are unfamiliar to you. Draw a picture of how you think the devices are used.

B Visit a local museum. Stop and examine an item or device the purpose of which you are unfamiliar with. Draw a picture of how you think it is used. Find out how the device is actually used.

C Arrange a trip to an electronics shop. Find out which devices use a batteries and which are connected to the power grid with a cord.

5

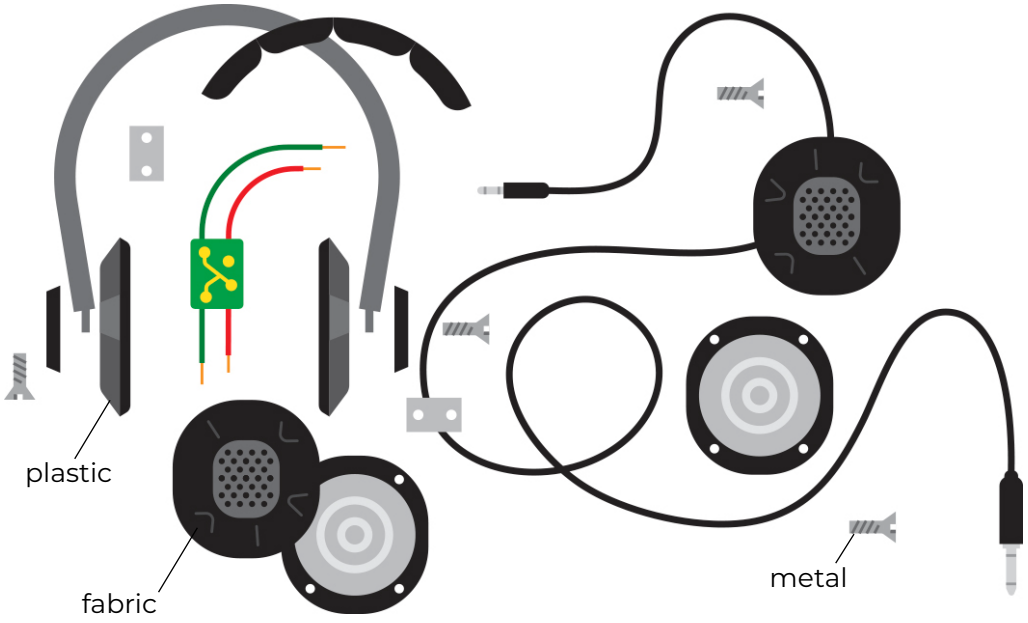
Safe use and recycling of electrical devices

- Practise sorting waste and consider the importance of recycling.
- Learn about how to identify broken electrical devices and why faulty devices must not be used.

MUSEUM EXERCISES

A Puzzle: This device contains metal. The casing is made of metal and plastic. It runs on electricity. It uses water when running. Clothes are cleaned in it.

B Examine what components and materials have been used to manufacture the device.
Imagine that the device has been broken down into small parts so that the materials can be recycled. Where would you place the materials for recycling?



5

EXPLORING THE TOPIC IN YOUR OWN ENVIRON-MENT

ORIENTATING EXERCISES

A Practise sorting waste with a sorting game.
For this exercise, you can use the HSY sorting game:
→ https://www.hsy.fi/sites/Esitteet/EsitteetKatalogi/Lajittelupelipaketti.pdf

B Concentration game. Image pairs depicting broken devices can be found in Appendix 3.

PROBLEM RESOLUTION EXERCISES

A Invent a machine that makes sweets. Draw what the electrically-powered machine contains and how the sweets are made. What materials will you need to manufacture the machine?

APPLIED EXERCISES

A Checking the condition of electrical devices.
Work in groups and carefully examine electrical devices in your immediate environment. Check the following things:

- ▸ Is the device clean (not dusty or otherwise dirty)?
- ▸ Is the casing of the device undamaged (there are no fractures and no pieces have broken off)?
- ▸ Is the power cord of the device intact (if the device includes a power cord)?
- ▸ Is the power plug undamaged?

! If you find faults in the devices, mark them with a red sticker to indicate that the device is broken and should not be used.
Devices with small faults that do not prevent safe use should be marked with a yellow sticker. Mark the devices that can be used safely with a green sticker. The children can either make the stickers themselves or use Post It notes as stickers.

B Visit a recycling centre. What kinds of items can be recycled?
What kinds of items must not be brought in for recycling?

6

Electricity as a phenomenon

▸ Learn about what a power circuit contains and what the purpose of conductors and insulants is.

▸ Learn about the paths through which electricity travels from the power plant to the home.

MUSEUM EXERCISES

Ⓐ **Puzzle:** One of these can be found in every room. It turns the lights on. Do you know why it can often be found next to a door?

Ⓑ **Make a pinwheel** (→ Appendix 4).

Ⓒ **Make a duster** (→ Appendix 5).

6

EXPLORING THE TOPIC IN YOUR OWN ENVIRON-MENT

ORIENTATING EXERCISES

Ⓐ **Resolve a word puzzle.** (→ Appendix 6).

PROBLEM RESOLUTION EXERCISES

Ⓐ **Make a pinwheel** (→ Appendix 4).

Ⓑ **Make a duster** (→ Appendix 5).

APPLIED EXERCISES

Ⓐ **Learn about static electricity.**

You will need the following for the exercise
▸ a plastic spoon
▸ sewing thread or thin yarn about one metre in length
▸ a piece of woollen cloth, felt or fleece (pieces of clothing such as scarves, mittens, woolly hats or shirts are also suitable)
▸ a selection of small items such as rulers, pencils, brushes, toys, etc.

Preparations: tie one end of the thread to the spoon and the other to the backrest of a chair, for example, in such a way that the spoon hangs freely without touching anything.

➔ Rub the selected small items against the fabric one at a time. Then bring the item carefully close to the spoon (the items must not come into contact with the spoon) and see if the items draw the spoon towards themselves.
If the spoon moves towards the item, frictional electricity has been formed.
The spoon test can be used to find out what kinds of materials generate frictional electricity (→ these items are insulants) and which do not (→ these items are conductors).

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B Colour in the picture: the power cords [1] (→ Appendix 7) black, transformers and substations [2] yellow, and power distribution cabinets [3] green.

C Repair the power circuit. In order for power to flow and the device to operate properly, the power circuit must be intact and all of its components must conduct electricity. Repair the circuit in the picture by selecting a power-conducting component for the broken point in the circuit.

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Background information for teachers

Electricity arrives in Finland

Before electricity, many familiar electrical devices operated mechanically or people used other sources of heat and light, such as fire.

Electricity makes many devices and machines safer and more efficient to use: this is why we use so many electrical devices in modern times. We have also learned how to convert information into an electronic format. Today, content such as songs, photographs, drawings or texts can be stored entirely in electronic form.

Electricity is required everywhere. If the supply of electricity is interrupted, electrical devices cannot be used and information stored in an electronic format becomes inaccessible. This is why it is important to understand how everyday technology works and how it has developed. It is also important to learn what to do during a power outage.

The electricity we use is produced in power plants from a variety of sources. Electricity can be produced by means of water, wind, sunlight or substances (as an example, nuclear power plants use uranium, thermal power plants use charcoal or recycled materials, and so on). Electricity produced in power plants is used for heating, lighting and powering up everyday devices and machines.

Electricity in the city

The urban structure enables a dense power transmission network. This means that cities can use electricity efficiently for a variety of purposes. The power grid itself is often hidden inside structures or underground, but you can determine where electricity is used based on electrically-powered items in the constructed environment.

Cities contain a lot of traffic, buildings to be heated and spaces to be illuminated. Replacing other forms of energy used for transport and heating with electricity reduces pollution. Electrically-powered vehicles are also quiet.
In addition to heating and lighting, electricity can also be used for cooling.

Electrical devices in the home and storing electricity

Electricity produced in power plants from wind, water flow or sunlight can be used in a variety of everyday devices and machines.
The devices can be connected to the power grid with a power cord.

You can also connect a chargeable battery to a power grid. Once it has been charged, the battery can then be installed in a device. Some devices and machines contain built-in batteries.

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Electrical devices often have cords, plugs, batteries, motors and other moving parts. Devices and machines convert electricity into something else (sound, light, heat or motion), based on their purpose of use.

Safe use and recycling of electrical devices

Electricity is generated by the movement of imperceptibly small particles called electrons. In order for an electrical device to function, the electrons must be able to move freely in the power circuit, which is formed by the power cords of the device and the power grid or a battery. If the device is not connected to the power grid or is missing a battery, it will not function since the electrons cannot flow within the circuit.

On its own, a single electron is harmless. However, countless numbers of electrons flow inside electrical circuits, which multiplies their power. If a part of an electrical device breaks or fails, electrons can escape the circuit and be fatal for humans (and other organisms). This is why it is important to not use broken devices. Signs of a broken device are that it does not operate properly, the power plug or cord is broken, it emits smoke or odours, or it makes unusual noises.

The materials of broken decommissioned electrical devices and machines can be recycled and used to manufacture new products. This is why it is important to recycle old and broken electrical devices.

Electricity as a phenomenon

The electricity produced in power plants is conveyed to people for use through power transmission networks. The network starts at the power plant, which sends out electricity via transmission cables. Large amounts of electricity are transmitted through the high-voltage network, which is not suitable for households to use. The power must first be routed to a transformer to reduce the voltage. The transformer lowers the voltage enough for the electricity to be transmitted to households through low-voltage cables.

Transformers can either increase or reduce the voltage of electricity, which means that a power transmission network must include several transformers. The transformers are situated in power substations. In order for electricity to be distributed to multiple locations at the same time, a power distribution centre is needed. In individual buildings, the power first arrives in the distribution board, through which it is distributed to various electrical devices. Small amounts of electricity can also be transmitted from one device to another without cords.

Today, smaller power plants or power production devices can also be used

to produce electricity alongside actual full-sized power plants. For example, you can produce electricity by means of a miniature wind turbine or you can connect a small solar panel to your phone. A small amount of electricity is sufficient to power an individual building or device, but more is needed for continuous power supply. This is why it is important for power plants and the power transmission network to function properly. It is a good idea to prepare for a power outage at your summer cabin, for example, by bringing a long some batteries or a small power generator of your own (e.g. solar panel or wind turbine).

Some materials and substances convey the flow of electrons very well while some do not. Materials that enable the free flow of electrons are called conductors. Metals are excellent conductors, which is why power cords are made of metal. Materials through which electrons cannot flow are called insulants. Plastic is a good insulant because it does not conduct electricity. This is why the metal in a power cord is covered in plastic shielding. Insulated cables are safe for people to use.

Insulants, too, contain plenty of electrons and you can observe their intermittent motion by means of static electricity tests: by rubbing various insulants together, for example. The insulants do not permit electrons to flow, so they stay in place. This can be observed based on whether some items draw others towards them or push them away.

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Answers to the exercises

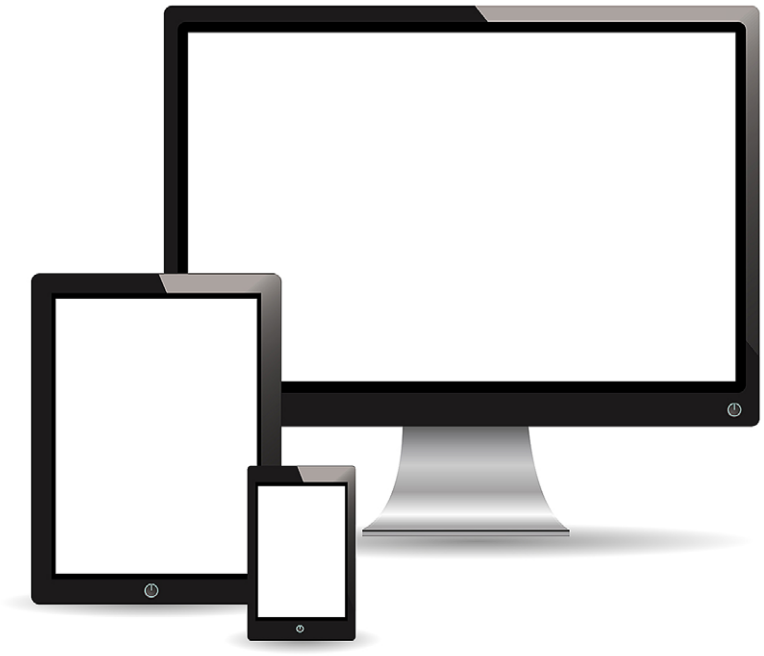
page 6: Puzzle: Toothbrush
page 9: Puzzle: Tram
page 9: Pictures in order: a crossing of the road at Mannerheimintie, Horse cart and a wooden building, Bus number 62 at Rautatientori, Helsinki Railway station, Urheilupuisto subway station
page 12: Puzzle: Television
page 12: Strange items exercise: Tie ironing tool
page 12: Exercise:
the device uses electricity to produce heat (→ clothes iron)
the device uses electricity to produce sound
(→ radio), the device uses electricity to produce motion
(→ mixer), the device uses electricity to produce light
(→ flashlight), the device uses electricity to produce air flow
(→ vacuum cleaner)
page 14: Puzzle: Washing machine
page 16: Puzzle: Light switch
page 17: Solutions to the word puzzle: Museum, Recycle, Cable, Sun, Heat
page 18: Any item made out of metal could be used to repair the power circuit

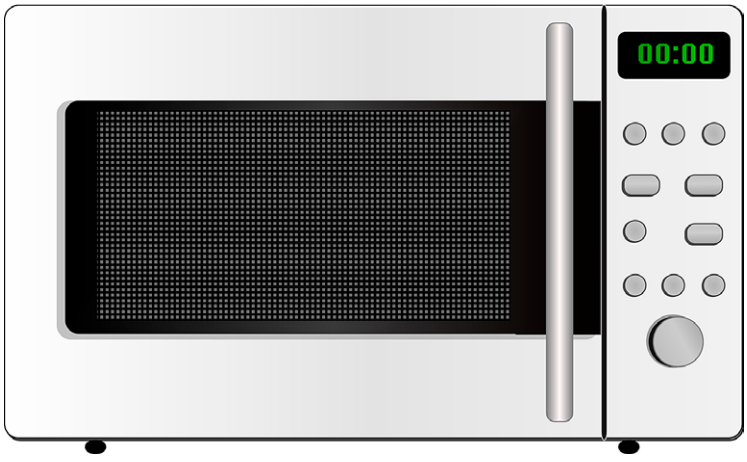
Appendix 1

➔ Highlight the cords with different colours.

Appendix 2

EXAMPLE PICTURES FOR THE GAME
TO BUILD A POWER CORD

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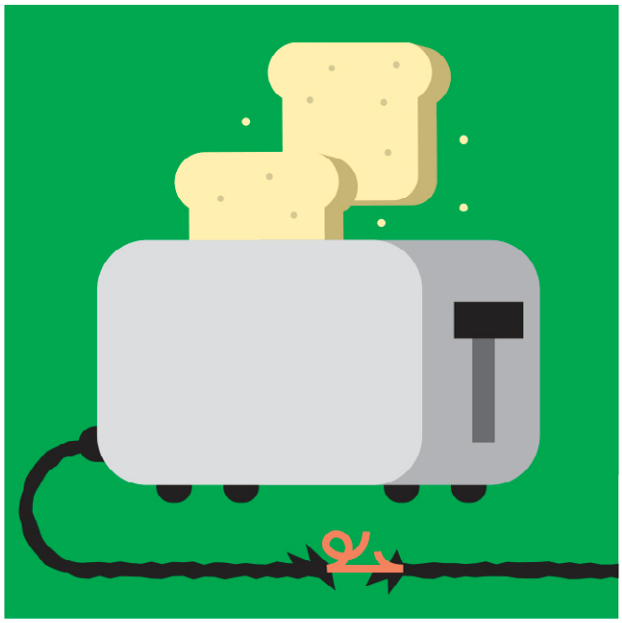
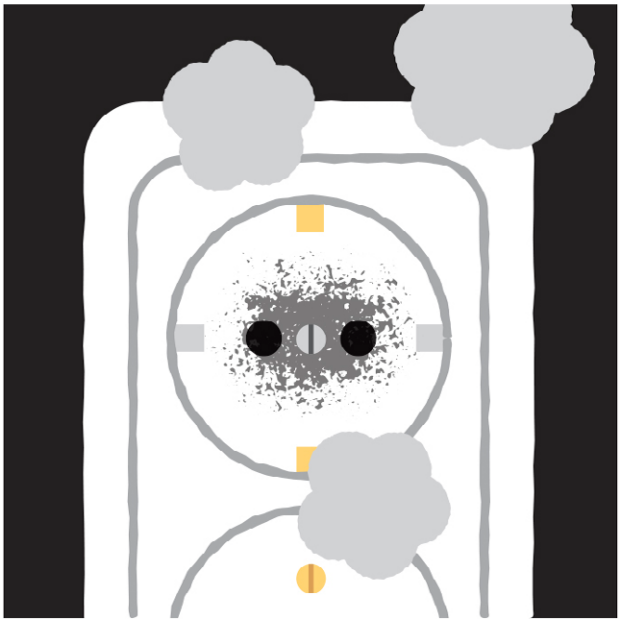
Appendix 3

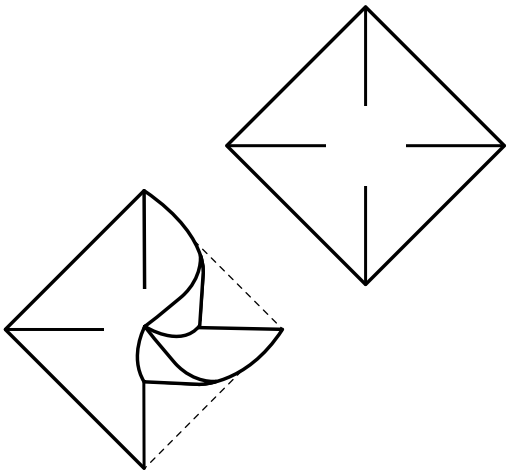
'BROKEN DEVICES'
CONCENTRATION GAME





Appendix 4

Supplies:
paper, straws, metal wire, buttons and/or hama beads glue, tape, tacks.



❶ Take a piece of paper 21 × 21 cm in size (can be easily folded from an A4 sheet).

❷ Cut about 10 cm towards the centre of the sheet from each corner. Fold or tape the corners to the middle of the sheet.

---

❸ Press a tack through the centre through all the folded corners. Use a tack to punch a hole through other end of the straw.

❹ Take a piece of metal wire (approx. 10 cm in length). Make a knot in the other end or attach a hama bead or button to it as a decoration. Thread the wire through the hole in the pinwheel.

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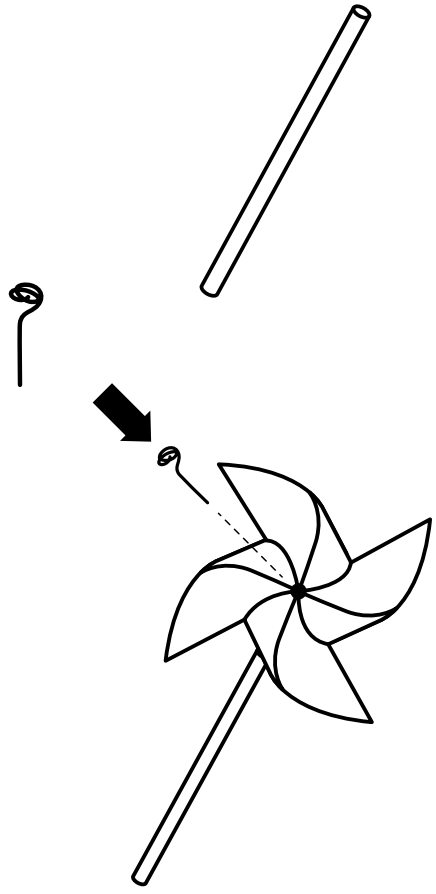
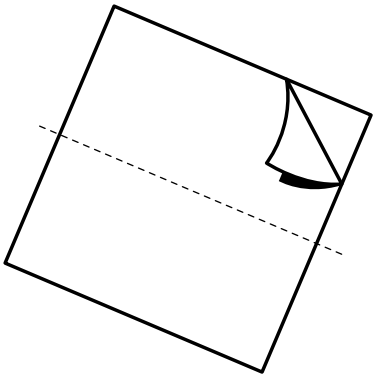
❺ Place a hama bead on the wire behind the pinwheel and attach the pinwheel to the hole in the straw with the remaining wire. You can clip off any extra wire.
Blow on the wheel to see that it works!



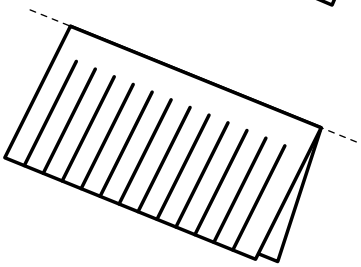
SOURCE: MUSEUM OF TECHNOLOGY

Appendix 5

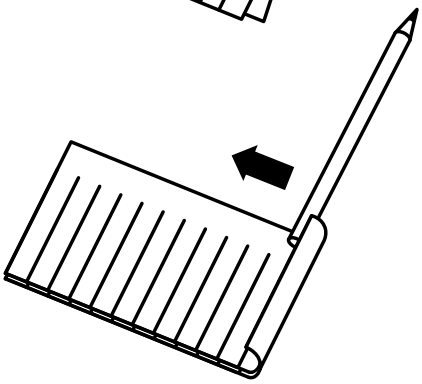
Supplies:
Napkins, pencils, tape or rubber bands.



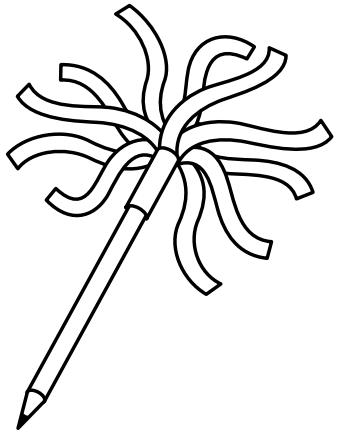
❶ Peel a thin layer of paper off the napkins. Use the other layers for another duster.



❷ Fold the paper in half. Use scissors to cut or your fingers to tear 1–1,5 cm strips of paper that remain connected to each other on one end.



❸ Wrap the strips around the end of a pencil. Fasten the strips in place with tape or a rubber band.



❹ The duster is now ready for use!

Appendix 6

Find the following words in the puzzle:

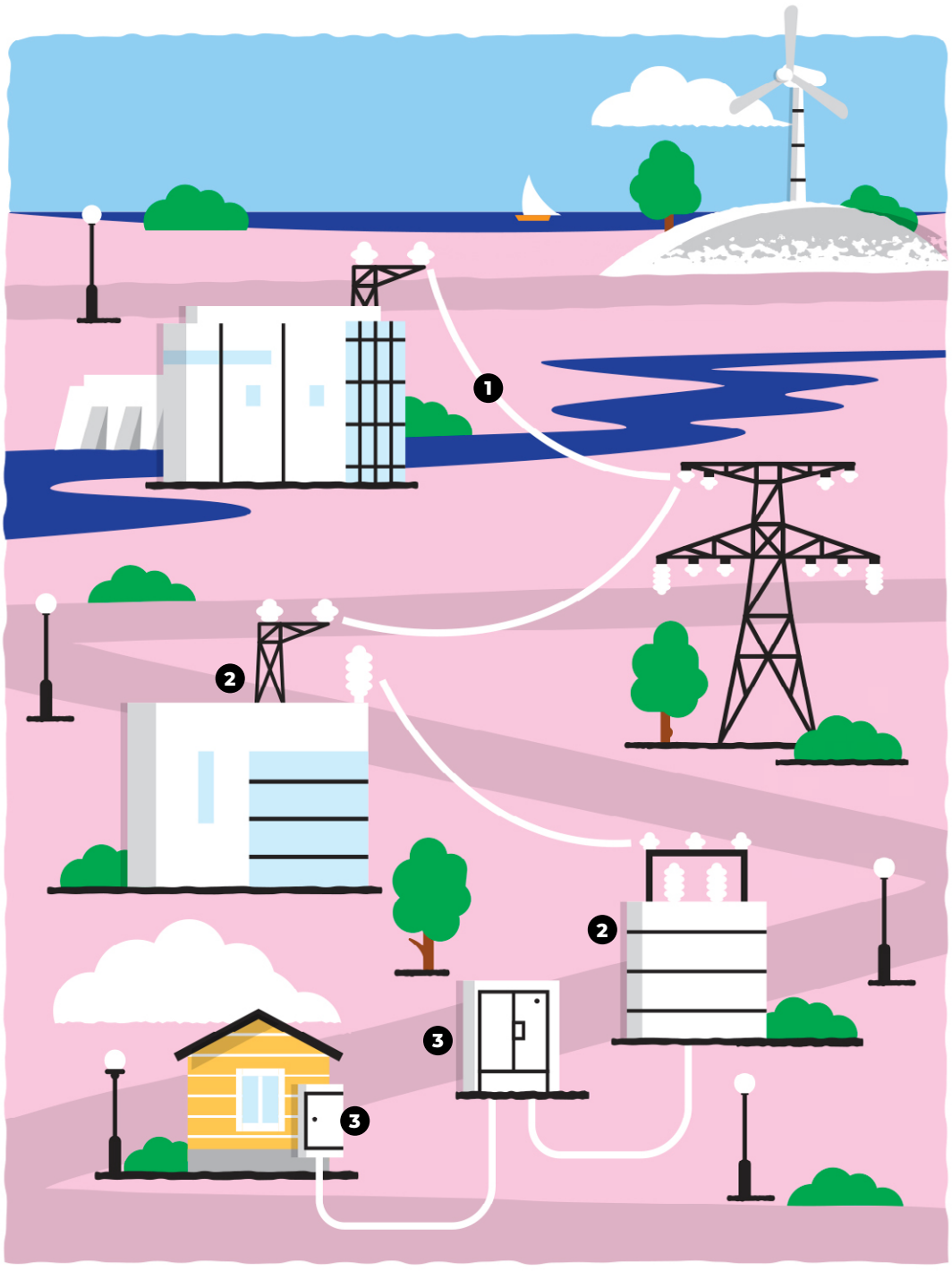
1. Cable
2. Heat
3. Museum
4. Recycle
5. Sun

S N U S F C Z S T O
Y J L P U E D N F M
S O D V M P C Y H U
F A B Q K U K K M Q
S T Z Q I E S C J Z
X D V H I A Y E V C
T X C H L B I W U Y
U A R E C Y C L E M
J D E J E L B A C B
K W T H Q R E V K P

Appendix 7

Colour in the picture:

1. the power cords black
2. transformers and substations yellow
3. power distribution cabinets green



THE GHOST
& the Invention Device

Exciting electricity teaching materials
for preschool and early education teachers
and club instructors.
The teaching materials provide tips
and exercises for examining electricity
as a phenomenon, electrical technology
and the uses of electricity.

If you decide to share what your pupils
create based on the exercises provided
here on social media, please use the tags
@tekniikanmuseo and #keksintökoje

The Finnish Association of Electrical Safety STEK ry maintains
the Sähkölä website www.sahkola.fi which is intended for
teachers. It contains a wealth of materials intended for learners
of varying ages. The animations available on the website can
also be used to supplement these learning materials.
Enjoy electrifying insights in learning about electricity!

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